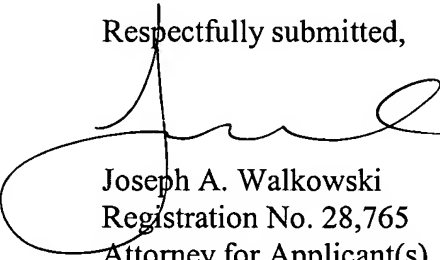


**REMARKS**

This amendment corrects errors in the text of a typographical nature. Paragraph numbering has been inserted to more fully comply with current Patent Office practice. The amendments do not surrender any scope of any claim as originally filed. Entry is respectfully solicited.

This amendment is submitted concurrently with the submission of a Request for Continuing Examination and, therefore, no additional petition or fee is required. No new matter has been added.

Respectfully submitted,



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Date: September 16, 2005  
JAW/csw

Enclosures: Appendices A and B

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# **APPENDIX A**

**(CLEAN VERSION OF SUBSTITUTE SPECIFICATION EXCLUDING CLAIMS)**

**(Serial No. 10/042,749)**



PATENT  
Attorney Docket 2269-7141.2US (95-0685.02/US)

NOTICE OF EXPRESS MAILING

Express Mail Mailing Label Number: \_\_\_\_\_

Date of Deposit with USPS: \_\_\_\_\_ December 4, 2002 \_\_\_\_\_

Person making Deposit: \_\_\_\_\_

APPLICATION FOR LETTERS PATENT

for

**MANUFACTURING OF FIELD EMISSION DISPLAY SCREENS BY  
APPLICATION OF PHOSPHOR PARTICLES AND CONDUCTIVE BINDERS**

Inventors:

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# **MANUFACTURING OF FIELD EMISSION DISPLAY SCREENS BY APPLICATION OF PHOSPHOR PARTICLES AND CONDUCTIVE BINDERS**

## **STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT**

**[0001]** This invention was made with Government support under Contract No. DABT63-93-C-0025, awarded by the Advanced Research Projects Agency (ARPA). The Government has certain rights in this invention.

## **CROSS-REFERENCE TO RELATED APPLICATIONS**

**[0002]** This application is a continuation of U.S. Patent Application Serial No. 09/054,552 filed April 3, 1998, now abandoned, which is a divisional of U.S. Patent Application Serial No. 08/587,722 filed January 19, 1996, now U.S. Patent No. 5,744,907 issued April 28, 1998, the entirety of which is incorporated herein by reference.

## **BACKGROUND OF THE INVENTION**

**[0003]** The present invention generally relates to an improvement in the binding of phosphors to the display screen of field emission displays and, in particular, to the use of inorganic and organic binder materials that may be either conductive or semi-conductive.

**[0004]** Field emission display (FED) technology utilizes a matrix addressable array of pointed, thin film, cold field emission cathodes in combination with a phosphor luminescent screen, as represented, for example, by U. S. Patent No. 5,210,472, the disclosure of which is incorporated herein by reference. An emissive flat panel display operates on the principles of cathodoluminescent phosphors excited by cold cathode field emission electrons. A faceplate having a cathodoluminescent phosphor coating, similar to that of a cathode ray tube, receives patterned electron bombardment from an opposing baseplate thereby providing a light image that can be seen by a viewer. The faceplate is separated from the base plate by a narrow vacuum gap. Arrays of electron emission sites (emitters) are typically sharp cones on the cathode that produce electron emission in the presence of an intense electric field. A positive voltage is applied to an extraction grid, relative to the sharp emitters, to provide the intense electric field required for

generating cold cathode electron emission. Prior art Figure 1 is a photocopy of Figure 1 of the above-referenced U.S. Patent No. 5,210,472. Figure 1 shows a perspective view of the baseplate of a field emission display. As shown, the baseplate includes a plurality of base electrode strips 12A-12C, and a plurality of grid electrode strips 11A-11C. A plurality of field emission cathodes, or emitters, 13 are disposed on the base electrode. The tip of each emitter is surrounded by a grid strip aperture 14. In operation, voltages applied to the base electrode and the grid electrode cause selected emitters to emit electrons that travel towards a faceplate.

[0005] FEDs are less tolerant to particle shedding from the faceplate than CRTs and, thus, excellent and repeatable adhesion and faceplate integrity are required. The cathode of the field emission display is in very close proximity to the faceplate and is sensitive to any electronegative chemicals arriving on the cold cathode emitter surfaces, which could absorb them and increase the value of the emitter work function. Typically, FEDs are operated at anode voltages well below those of conventional CRTs. The material properties of the surface, distance along the surface, and changes in the orientation of the surface relative to a straight line between the two voltage nodes determine the voltage at which flashover between the cathode and faceplate occurs. Because FEDs employ lower anode voltages, phosphor material screening and the process of binding them to each other and to the faceplate have to be optimized and tightly controlled to minimize the dead layer and allow for effective excitation of the phosphor. Most phosphor lifetimes are largely determined by the total accumulated charge delivered per unit area through the life of the display.

#### SUMMARY OF THE INVENTION

[0006] The present invention relates to the use of binders, both inorganic and organic, for providing sufficient binding action to hold powder phosphor particles together, as well as on a glass screen of a field emission display. The binder materials can be either conductive or semi-conductive in nature.

#### BRIEF DESCRIPTION OF FIGURES

[0007] Figure 1 shows a perspective view of the baseplate of a prior art field emission display; and

[0008] Figure 2 shows a block diagram of a field emission display constructed according to the invention.

#### DETAILED DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

[0009] Field emission displays emit visible light following excitation of a phosphor screen via electrons from a cold cathode based on either silicon (Si), molybdenum (Mo), tungsten (W), etc., microtips. As the phosphor-coated screen is in very close proximity with the microtips, any particles which come loose from the phosphor screen could cause fatal damage to the tips or shorting. As such, the present invention proposes the use of binders, both inorganic and organic, for providing sufficient binding action to hold the powder phosphor particles together, as well as on a glass screen. Furthermore, as the phosphor screen of a field emission display is not normally aluminized, as are most cathode ray tubes, there is a possibility of space charge build up that can lead to a decreased luminescent efficiency. Thus, the present invention further proposes that the binder materials used be of a conductive or a semi-conductive nature to eliminate this problem.

[0010] Preferably, the binder, according to the present invention, is polyvinyl alcohol, potassium silicate, ammonium silicate, or it may be such that heating the phosphor/binder screen yields a conductive binder, e.g., tin (II) 2-ethylhexanoate, tin (IV) isopropoxide, tin (II) oxalate, titanium (IV) ethoxide, zinc 2,4-pentane dionate, zinc acetate, zinc oxalate. Suitable binder materials include poly(propylene carbonate), poly(propylene carbonate) and poly(ethylene carbonate) sold by PAC Polymers, Inc. of Greenville, DE as QPAC-40 Emulsion, QPAC-40 and QPAC-25, respectively.

[0011] For these compounds, a simple heating process removes the organics and leaves behind a conducting or semiconducting oxide that binds the phosphor particles to each other and to the glass screen. The glass screen is normally coated with transparent conducting film, such as indium tin oxide (ITO), zinc oxide (ZnO), tin oxide (SnO<sub>2</sub>) with antimony (Sb) doping, cadmium oxide (CdO), cadmium tin oxide Cd<sub>2</sub>SnO<sub>4</sub>, cadmium stannate, etc.

[0012] In general, these organometallic compounds would be from the following group: cadmium (Cd), titanium (Ti), zinc (Zn), tin (Sn), indium (In), antimony (Sb), tungsten

(W), niobium (Nb), etc., which would form conductive and semiconductive oxides when heated. In addition, these oxides are preferably transparent.

[0013] Three phosphors (green, red, and blue) are applied to the faceplate in separate (wet application, i.e., as a slurry or electrophoresis or dry application, i.e., as a powder on a wetted faceplate) operations. The phosphor particles range in size from 1 to 5  $\mu\text{m}$  in diameter and are coated to a thickness of 1-10  $\mu\text{m}$ , or 1-3 particles deep. The subject binders are applied with or after the phosphors in a similar wet operation.

[0014] The preferred method for applying these binders is by spray coating or by adding to the phosphor material during its deposition.

[0015] In another embodiment, the anode may be patterned with a mask, such as photoresist, to prevent accumulation of the conductive binder in unwanted areas, such as between conductive traces.

[0016] The binding material is heat treated to temperatures in the range of to 20°C to 600°C for a period of from 2 to 200 minutes under pressures of from 760 to  $10^{-6}$  Torr in an atmosphere of air or somewhat reducing atmosphere, depending on the type of binder.

[0017] Figure 2 shows a block diagram of a portion of a field emission display 100. Display 100 includes a baseplate 110 of the type shown in Figure 1 having conical emitters. Display 100 also includes a faceplate 120. Faceplate 120 includes a glass screen 122. As stated above, the glass screen 122 is normally coated with a transparent conducting film 124 such as ITO. Faceplate 120 also includes a layer 126 of phosphor and binder material. The binder material holds the phosphor particles together as well as to the faceplate.

[0018] The present invention may be subject to many modifications and changes without departing from the spirit or essential characteristics thereof. The present embodiment should, therefore, be considered in all respects as being illustrative and not restrictive of the scope of the invention as defined by the appended claims.

## ABSTRACT OF THE DISCLOSURE

Conductive or semiconductor binders, both inorganic and organic, are used for providing sufficient binding action to hold powder phosphor particles together, as well as to the glass screen of a field emission display device.

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# **APPENDIX B**

**(VERSION OF SUBSTITUTE SPECIFICATION EXCLUDING CLAIMS  
WITH MARKINGS TO SHOW CHANGES MADE)**

**(Serial No. 10/042,749)**

PATENT  
Attorney Docket 2269-7141.2US (95-0685.02/US)

NOTICE OF EXPRESS MAILING

Express Mail Mailing Label Number: \_\_\_\_\_

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APPLICATION FOR LETTERS PATENT

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## ~~Cross-Reference to Related Application~~ CROSS-REFERENCE TO RELATED APPLICATIONS

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[0004] Field emission display (FED) technology utilizes a matrix addressable array of pointed, thin film, cold field emission cathodes in combination with a phosphor luminescent screen, ~~as represented for example~~ represented, for example, by U. S. Patent No. 5,210,472, the disclosure of which is incorporated herein by reference. An emissive flat panel display operates on the principles of cathodoluminescent phosphors excited by cold cathode field emission electrons. A faceplate having a cathodoluminescent phosphor coating, similar to that of a cathode ray tube, receives patterned electron bombardment from an opposing baseplate thereby providing a light image ~~which~~ that can be seen by a viewer. The faceplate is separated from the base plate by a narrow vacuum gap. Arrays of electron emission sites (emitters) are typically sharp cones on the cathode that produce electron emission in the presence of an intense electric field. A positive voltage is applied to an extraction grid, relative to the sharp emitters, to provide the intense electric field required for generating cold cathode electron emission. Prior art Figure

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[0005] FEDs are less tolerant to particle shedding from the faceplate than ~~CRTs, and thus CRTs and, thus,~~ excellent and repeatable adhesion and faceplate integrity are required. The cathode of the field emission display is in very close proximity to the faceplate and is sensitive to any electronegative chemicals arriving on the cold cathode emitter surfaces, which could absorb them and increase the value of the emitter work function. ~~Typically~~ Typically, FEDs are operated at anode voltages well below those of conventional CRTs. The material properties of the surface, distance along the surface, and changes in the orientation of the surface relative to a straight line between the two voltage nodes determine the voltage at which flashover between the cathode and faceplate occurs. Because FEDs employ lower anode voltages, phosphor material screening and the process of binding them to each other and to the faceplate have to be optimized and tightly controlled to minimize the dead layer and allow for effective excitation of the phosphor. Most phosphor lifetimes are largely determined by the total accumulated charge delivered per unit area through the life of the display.

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[0010] ~~Preferably~~ Preferably, the binder, according to the present invention, is polyvinyl alcohol, potassium silicate, ammonium silicate, or it may be such that heating the phosphor/binder screen yields a conductive binder, e.g., ~~tin(II)~~ tin (II) 2-ethylhexanoate, tin (IV) isopropoxide, tin (II) oxalate, titanium (IV) ethoxide, zinc 2,4-pentane dionate, zinc acetate, zinc oxalate. Suitable binder materials include poly(propylene carbonate), poly(propylene carbonate) and poly(ethylene ~~Carbonate~~) carbonate sold by PAC ~~Polymers~~ Polymers, Inc. of Greenville, DE as QPAC-40 Emulsion, QPAC-40 and QPAC-25, respectively.

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[0012] ~~In-general~~ general, these organometallic compounds would be from the following group: cadmium (Cd), titanium (Ti), zinc (Zn), tin (Sn), indium (In), antimony (Sb), tungsten (W), niobium (Nb), ~~etc.~~ etc., which would form conductive and semiconductive oxides when heated. In addition, these oxides are preferably transparent.

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[0018] The present invention may be subject to many modifications and changes without departing from the spirit or ~~essential~~, essential characteristics thereof. The present embodiment ~~should therefor~~ should, therefore, be considered in all respects as being illustrative and not restrictive of the scope of the invention as defined by the appended claims.

•

## ABSTRACT OF THE DISCLOSURE

•       Conductive or semiconductor binders, both inorganic and organic, are used for providing sufficient binding action to hold powder phosphor particles ~~together~~ together, as well as to the glass screen of a field emission display device.

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